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SCIENCE

NEW YORK, MAY 12, 1893.

MOUNT ORIZABA OR CITLALTEPETL.

BY J. T. SCOVELL, TERRE HAUTE, IND.

THE central portion of Mexico is a plateau from 3,000 to 8,000 feet in elevation. About 19° north of the equator a broad belt of this plateau is composed of volcanic formations, which culminate in the snow-clad peaks of Citlaltepetl, Popocatepetl, and Ixtaccihuatl.

Citlaltepetl stands on the eastern margin of the plateau, about 80 miles from the coast, its eastern slope rising from the Gulf, the others from the plateau.

Orizaba, the name of a city on the eastern slope, is the name by which the mountain is best known to foreigners, but, seen from a distance, rising far above all surrounding peaks, with its crown of glistening snow, the Indian name of Citlaltepetl, star mountain, seems singularly appropriate.

Popocatepetl, smoking mountain, and Ixtaccihuatl, woman in white, rise from the plateau about 100 miles west of Citlaltepetl. These old volcanoes, with Mount St. Elias in Alaska, are the culminating points of North America.

FIG. 1.—Southwestern slope of Citlaltepetl, taken Aug. 3, 1891, from the 12,800 ft. level. *a*. The 16,000 ft. level where the horses are left. See moraine just above and to the left of *a*. Tree in foreground is just above the cave.

Citlaltepetl, situated just within the northern boundary of the torrid zone, rising from tropical waters to polar snows, presents within narrow limits an epitome of the earth. On the slopes of this mountain may be found every variety of surface and every kind of climate, they produce all classes of vegetation and afford a congenial home for all sorts of animal life. This region, with its wonderful variety of scenery and its myriad forms of life, is of special interest to the student of science, whatever his department.

In July, 1891, a party consisting of W. S. Blatchley of Terre Haute, Ind., entomologist; Henry E. Seaton, now of Cambridge, Mass., botanist; A. J. Woolman of South Bend, Ind., icthyologist; U. O. Cox of Mankato, Minn., ornithologist; and the writer, visited the eastern slope of Citlaltepetl, making interesting collections of the varied forms of life which abound in that region. We found some forms new to science, found some familiar forms in unexpected localities, saw many interesting things, making the trip an interesting and valuable one to us. The different members of the party have published, or are preparing to publish, accounts of the work done in their several departments.

There is considerable discrepancy among observers as to the elevation of these Mexican mountains, until recently Popocatepetl has been considered the highest elevation, but determinations made within the last three or four years show that Citlaltepetl rises considerably higher than its rivals further west. Dr. Franz Kaska, using mercurial barometers, made the elevation 18,270 feet. Professor A. Heilprin, using an aneroid barometer, adjusted by a mercurial, and estimating his station as 120 feet below the true summit, made the elevation 18,205 feet. My aneroid made the elevation estimated at 120 feet only 86 feet. Making this correction, the elevation would be 18,171 feet. Mr. O. G. Bunsen, C.E., of the University of Texas, and the writer, using railway levels to 8,313 feet, carried a line of spirit levels up to 14,000 feet, then using our aneroid barometer, made the elevation 18,179 feet. In April, 1892, by triangulation from the 13,000 feet level of Bunsen and Scovell, I made the total elevation 18,314 feet. These results, arrived at by different methods, seem closely confirmatory. Popocatepetl is about 700 feet lower than Citlaltepetl, and Ixtaccihuatl is about 700 feet lower than Popocatepetl. In a paper before the National Geographical Society, Dr. Mendenhall gave the elevation of Mt. St. Elias as 18,010 ft., so that Mt. Orizaba seems to be the highest elevation in North America.

Climate of Glaciers.

In this region the summer is a wet season and the winter a dry one. In the sunshine it is generally hot, summer or winter, even on the upper slopes, but in the shade or at night it is usually cool and pleasant, anywhere between 4,000 feet and 10,000 feet. In summer the northeasterly winds seem to prevail, as shown by the fact that a tract of country, about 50 miles wide, to the southwest of Citlaltepetl, was dry and dusty, receiving only an occasional shower, while on either side of this region it rained almost every afternoon. The explanation seems to be that the winds from the northeast, losing their moisture on the mountain, flow over the region to the southwest as dry winds. Above the elevation of 12,500 feet, there were evidences of westerly winds, as leaning trees, drifting sands, more abundant vegetation on the eastern side of rocks, etc. But the winds most noticeable, summer and winter, were cold winds down the mountain at night, and warmer winds up the mountain by day. There is in general no rainfall during the winter, during the summer it is scanty from the coast up to 1,500 feet, then plenty of moisture to the summit, except on the southwest above 8,000 feet. The rains on the lower slopes are represented by snows on the upper slopes, but, while it rains almost every afternoon below, the snows above are less frequent, sometimes eight or ten days passing without a storm. But snow falls often enough during the summer to keep the peak covered down to about the 14,000 feet level, forming a distinct snow-line. If for a few days no snow falls, the old snow melts, and the snow-line rises, while an exceptional storm may carry the snow down to 11,000 feet or below, but 14,000 feet seems to

be about the average level of the snow-line. As the dry season comes on, the snowfall gradually ceases, and the snow that has accumulated during the summer rapidly disappears under the heat of a tropical sun; rocky ridges and loose sands appear on the south and east, while an extensive glacier is disclosed on the north and west. (See Figs. 1 and 5 for summer views and 2 and 4 for winter views.) The glacier on the southwest extends downward to about 16,250 feet, narrow tongues of ice reaching 400 or 500 feet further downward, while on the north the main body descends nearly to 15,000 feet. In April, 1892, near the close of

FIG. 2.—The Peak from the 18,000 ft. level on the southwest. Sierra Colorado on the left.

the dry season, the snow had disappeared and the ice had retreated some distance, leaving a valley or series of basins between the glacier and the crest of the moraine. In these basins were streams and ponds of water, small bodies of ice and broken rocks. (See Fig. 2 and Fig. 3.) The moraine is from 100 to 300 feet high on its outer face, and from nothing to 15 feet on its inner slope. The moraine is as steep as loose rocks will stand, but the rocks composing it are by no means loose, they are bound together with ice. The ice is continually melting from the outer face of the moraine, but the mass is practically constant, apparently supplied by water from the melting glacier above. Water from the glacier sinks slowly into the moraine, becoming ice again, later it melts from the face of the moraine and is absorbed by the rocks and sands below, without forming streams. I only saw one instance of a stream across the moraine, and it soon disappeared in the porous rocks. Dry drainage channels indicate that sometimes there is water enough to form streams, but, in general, there are no streams above 12,000 feet, and those below are few and small, on account of scanty rainfall and porous rocks. While it snows frequently during the summer, the total amount does not seem to be very great. The slope on the north is more gradual, so that the glacier on the north, measured along the slope, is about five miles long, while on the west it is not more than two miles in length (see Fig. 6). The width is from eight to ten miles, and the thickness or depth from 10 feet to 50 feet. I found no polished bowlders or striated rocks, the only evidences of motion were occasional crevasses, and the interval between the moraine and the ice. During the summer the glacier probably advances to the moraine, and both are generally covered with snow, but, on a photograph of the peak (Fig 1), taken from an elevation of about 13,700 feet, Aug. 2, 1891, after eight days without snow, the moraine can be seen as a sort of terrace across the slope of the mountain, while on July 28 and 29 it was entirely hidden by snow. The fact of the glacier on the west and north seems to indicate that more snow falls on those slopes, and that the moisture from which it is formed comes from the west. But the moisture might come from the Gulf, and the snow formed on the east be carried to the western slopes by the wind. From the storms I saw, I judged that the snow was somewhat equally distributed over the mountain, whether the storm was westerly or easterly, and that the glacier on the north, and the naked rocks and sands on the south, were due to the fact that more snow melted on the south, rather than that more snow fell on the north.

At first I felt sure that the glacier had its source in the Pacific Ocean, but the more I investigated the matter the more I inclined to the view that much of it might have come from the Gulf. These glaciers are not very extensive as glaciers go, but they present many interesting features for study, and they are easily accessible, one can ride to the foot of the moraine with little danger or fatigue. And there is little or no danger attending the exploration of the glacier, beyond the physiological effects of the great elevation. From January to the middle of April the glacier may be seen at its best. No danger from snow-slides or avalanches, and crevasses are not numerous or extensive, and can be easily avoided. In summer, there are occasional snow-slides on the western slope, and after 10 A.M. on a clear day there might be some danger from snow-covered crevasses, but earlier the frozen snow forms a safe bridge over any crevasse there may be in the glaciers of the Star Mountain.

Ice is quarried from the glacier for domestic use in the surrounding towns. The ice is taken out and dragged to the foot of the moraine and there loaded on burros or horses for transportation to the lower slopes.

Geology.

Citlaltepetl, Sierra Negra, and Sierra Colorado are the culminating domes of a great mass of volcanic rocks, which forms part of the eastern boundary of the famous valley of Mexico. This mass, about 50 miles in diameter, at the 8,000 feet level, rises by gentle slopes to the 13,000 feet level, above which rise the peaks mentioned. Citlaltepetl, the highest, is somewhat cone-shaped, but Sierra Colorado and Sierra Negra are ridges trending east and west, each about a mile in length. Sierra Negra is about five miles, a little west of south, from Citlaltepetl, and Sierra Colorado is about three miles southwest of the same peak.

From the summit of these peaks down to the 8,000 feet level trachytes, basalts, and scoriaceous rocks seem to make up the bulk of the mass. Then there are 200 or 300 feet of Cretaceous limestone in nearly horizontal strata, then from 800 to 1,000 feet of Jurassic limestone, whose crumpled and folded strata remind one of the folded rocks of Arkansas, thence down to about 4,000 feet there are several alternations of basaltic rocks and Carboniferous limestones.

FIG. 3.—Detail at the foot of the glacier seen in Fig. 2.

Near the city of Orizaba the limestone is thick-bedded and associated with beds of quite good marble and beds of the famous Mexican onyx. Below the city there are Devonian limestones, then Carboniferous strata to about 2,500 feet, then Cretaceous to the coast sands, about 25 miles from the Gulf. I noticed the succession of rocks, but did not attempt to identify the limestones, I name them as identified by Mr. Hugo Finck of Cordoba.

According to Mr. Finck, the different phazes of the Glacial, Champlain, and Terrace periods are well marked in this portion of Mexico. The valleys of Orizaba and Cordoba were occupied by glacial lakes, over whose beds were deposited several hundred

feet of drift materials, and the bowlder-strewn region below the valley of Cordoba seems to indicate glacial or iceberg action.

The interstratification of volcanic and carboniferous rocks seems to indicate that this region has been a centre of volcanic energy for several geological ages, and that the limestones mentioned occupy a comparatively narrow space along the slopes of a great core of volcanic materials.

Of the peaks mentioned, Sierra Colorado has an elevation of about 14,000 feet, has a smooth, uniform outline, and the greater portions of its outcropping rocks are of a reddish color. I saw no indications of a crater. Sierra Negra has an elevation of about 15,000 feet, with a uniform surface, broken only on the south, where the old crater was situated. The southern or outer wall of the crater has been broken away, leaving the inner or northern wall as an abrupt and rugged section of the otherwise uniform slopes of the mountain (see Fig. 4). The outcropping rocks are dark basalts.

Seen from a distance, especially when covered with snow, Citlaltepetl seems quite symmetrical, but in winter, or on careful inspection in summer, great ridges of rock may be seen leading up, like giant ribs, from all directions quite to the summit, giving the peak a rugged, restless appearance, so different from the restful outlines of its less elevated neighbors.

The crater of Citlaltepetl occupies the whole summit. It is somewhat elliptical in form, measuring about 800 feet from north to south by 600 feet from east to west, with a depth of between 400 and 500 feet. The rim is nearly horizontal, the difference in level between the highest and lowest points being about 80 feet. The peak is a little steeper on the south than on the north, the slope being between 30° and 35° on the south, increasing toward the summit. Inside the crater, for 30 or 40 feet, the slope is about the same as outside, then about 200 feet of vertical walls, then a sharp talus to the centre, as shown in the annexed cross-section.

The hot sunshine by day and the intense cold at night, with plenty of moisture during a large part of the year, result in rapid disintegration of the crater walls, cutting down the rim, and filling up at the bottom with fragments from the crumbling walls, so that, geologically speaking, the crater can exist but a short time. The ruggedness of the slopes and the fact of a crater seem to indicate that the peak is of recent formation. Citlaltepetl has a hot top, at least great areas of the rim of the crater are hot, giving off steam and gases, and large quantities of rocky material at the summit are the product of this fumarole action. Sulphur is found in considerable quantities in the rim of the crater, but I saw no evidence of sulphur gases, or anything to indicate that sulphur is being deposited at the present time. While there are many evidences of the recent formation of this cone, there is no evidence of an eruption of lava within historic times.

Between 8,000 and 12,000 feet we saw no rocks, the mountain was covered with a thick mantle of finely pulverized volcanic material, in some cases a black sand, then a sand of lighter color, again it is clay, that frequently appears like rock, called by the Mexicans tepetate. This deposit rises to about the same elevation on Popocatepetl, and to a height of 10,000 feet on the Toluca Mountains west of the City of Mexico, and in some places it constitutes the rim of the valley of Mexico. The proposed tunnel for the drainage of the City and valley of Mexico is being dug through the tepetate, where it is at least 300 feet deep. The material was evidently deposited from water. It seems to indicate a more extensive lake system than now exists, and possibly more rapid erosion. The presence of this deposit at such high elevations seems to indicate an upheaval of some 3,000 or 4,000 feet within comparatively recent times. The geology of this region may not be very complicated, but fossils are not abundant, and there will doubtless be many conflicting opinions among geologists in regard to many of the geological features, yet the geologist who works up the region carefully will find an immense amount of very interesting geological material within a very limited area.

FIG. 4.—The Peak, seen over Sierra Negra, looking north from Esperanza during the dry season.

Life on Citlaltepetl.

With its base in the torrid zone and its summit in the region of perpetual snow, the eastern slope of Citlaltepetl produces almost every variety of vegetable and animal life. From the coast up to the 1,500 feet level, the country is practically a steppe; rainfall limited, soil sterile, vegetation scanty except along the streams; birds, insects, lizards, etc., abundant with but few mammals.

The region between 1,500 and 6,000 feet is the life-centre of this slope, the rainfall is abundant, and the soil, composed of the debris of volcanic and limestone rocks, is exceptionally fertile, producing a vegetation of great variety and luxuriance. The forest trees are seldom large but they exist in great variety, bearing ferns, orchids, bromelias, and other plants in great profusion on their trunks and branches; and every spot not shaded by the forest is crowded with a rank growth of herbaceous plants.

While in Cordoba, at an elevation of about 3,000 feet, I met a man from New York, who was buying Mexican lumber for the inside finish of his house, and went with him out to a little saw-mill, where there was not more than 2,000 feet of lumber in stock. From this small quantity 65 pieces were selected, and, on counting, the man found he had 41 different kinds, all valuable as finishing lumber. It is said that there are as many as 100 different kinds of trees on the slopes of Orizaba that are valuable for lumber, besides many that furnish valuable dyes, oils, or gums.

This region is also famous for its orchids and ferns. I saw in Cordoba a collection of 70 species of native orchids, and was told that the collection did not contain nearly all the species of the region. Mr. Hugo Finck has sent to the Kew gardens from this

region more than 50 species of ferns that were new to science. In this region are cultivated cotton, sugar-cane, coffee, pineapples, bananas, oranges, lemons, wheat, corn, potatoes, and many other interesting and valuable plants. The markets of Orizaba, at an elevation of 4,000 feet, displayed the most extensive variety of vegetables and fruits I ever saw in one collection. In this region there were many beautiful birds with some mammals and reptiles, but after plants insects were perhaps the most interesting zoölogical features of the locality. Professor Blatchley, in eleven days' collecting, took 160 species of moths, 145 of butterflies, 125 of coleoptera, 60 of hemiptera, and 40 of orthoptera. Other kinds of insects were numerous, but no collections were made of them. (See *Entomological News*, May, 1892.) From 6,000 feet upward the character of the different kinds of life changes rapidly, and the numbers of individuals and the variety of species are greatly diminished. In two days' collecting at 8,000 feet, Professor Blatchley only took about a dozen species of butterflies and beetles, and other forms of life seem to diminish in numbers quite as rapidly as the insects. Birds were an exception, for they were as numerous and varied at 8,000 feet as below.

Above 7,000 feet the different forms of life were more like those of the northern zones. There were oaks and elders, mustards, plantains, chickweeds, dock, violets, and familiar ferns; sparrows, meadow-larks, blackbirds, crows, woodpeckers and humming-birds were common along with many unfamiliar forms. But while vegetation was abundant, there were no forests similar to those so common in the temperate zone.

were much more abundant in the summer, though more orchids and some other plants bloom in the dry season. So that whether one visits Citlaltepetl in summer or winter he will find the plant-life interesting and well worthy of consideration. Insects were found up to the 14,000 feet level, and I saw two white butterflies at the summit, but the number of species found above 9,000 feet were very few. Between 8,000 and 9,000 feet there were some familiar birds, but above and below these levels most of the birds were peculiar to the locality. There seemed to be several species of humming-birds and many others with highly colored plumage, but we heard no songs more beautiful than we hear in temperate zones.

Sparrows were common up to 14,000 feet, and I heard one while on the summit, but whether he made his home there or was only a visitor like myself, I could not tell. Woodpeckers were busy about the trees between 13,000 and 14,000 feet, and several other birds were seen and heard at that elevation.

The rainy season was not favorable for collecting birds, but Professor Cox secured some very interesting specimens. Among reptiles, lizards were the most common, and they seemed just as lively near the 14,000 feet level as on the coast sands. Salamanders were found near the 14,000 feet level and at other localities on the slope, toads and tree-toads were seen, and collections of snakes were seen, but no live ones were taken by the party. Lizards are much more abundant in the dry season. I took more in three hours one day in April than the whole party saw in fifteen days in July. We saw rabbits, had mice in camp at 12,000 feet, saw evidences of moles, ground squirrels, and

Fig. 5.—Same as Fig. 4, but taken during the wet season.

Pines are common from 6,000 feet upward, but the forests of pine and spruce begin at about 9,000 feet, thinning out above 12,000 feet, so that the forest scarcely reaches 13,000 feet, although in some localities trees are found up to the 14,000 feet level. Above 13,000 feet a species of juniper spreads out over the rocks so that at a distance it appeared like moss. Along the slopes above 13,000 feet there were mustards, compositæ, castelleias, and a few other plants with two grasses, but no ranunculaceæ, claytonias, willows, or other water-loving vegetation so common on the high slopes of the Rocky Mountains in Colorado. The distribution is different in the two localities, on Orizaba individuals of the same species are seldom in groups, while on the other mountains great areas are often covered by one species. Near the 14,000 feet level, at the foot of a cliff looking east and south, where there was an indication of moisture, we found 14 or 15 species of plants, some of which had not been seen elsewhere above 12,000 feet. Only four species extended to any distance above this cliff, they were a castelleia and a draba, both nearly stemless, and scattering bunches of two grasses, probably an agrostis and a bromus, and these were passed at about 15,500 feet. The oaks stopped abruptly just above 9,000 feet. The ylite tree, whose thick bark furnishes a valuable dye, stopped as abruptly just above the 11,000 feet level.

A thistle, with a large white blossom, was seen only above 13,000 feet. Others again, as the castelleia, had a wide range, gradually diminishing in size as the elevation increased. Between 8,000 and 9,000 feet there were nearly as many flowers in April as in July, while above 9,000 feet in July we found nearly 75 species, but in April scarcely a half-dozen were found, of which the castelleia and draba were two. In the regions below, flowers

other burrowing animals. Saw tracks of antelope and coyotes above 14,000 feet, but mammalian life did not seem to be abundant. Fish are abundant in the streams of the dry season, but during the wet season the streams are muddy torrents, containing but few fish and it is almost impossible to do successful fishing in such rapid streams, so that but few species were taken. Those taken were interesting, some of which are probably new to science. The predominant forms of life were plants, insects, and birds.

Professor Seaton collected over 500 species of shrubs and herbs between the 3,000 feet and 14,000 feet levels, and made many interesting observations as to the distribution of plant-life within those limits and the families and genera most abundantly represented by the flora of Orizaba (see Proceedings Indiana Academy of Science, 1891). The vegetation, insect-life, and birds were all we expected, but serpents, tarantulas, scorpions, centipedes, and the like, so common in pictures of tropical life, were seldom seen. We found the zoölogical altitude zones somewhat like the latitude zones, but with interesting variations, the details of which will be brought out fully in the reports from the different members of the party.

The Ascent.

The ascent of Citlaltepetl is neither difficult nor dangerous. Leaving Vera Cruz or the City of Mexico by the morning train, one reaches San Andres early in the afternoon, then by tramway, about six miles, to Chalchicomula, a little town of some 3,000 people situated on the western slope of the mountain at an elevation of about 8,300 feet. At this place, guides and horses may be engaged and other preparations made for continuing the

ascent next day. A ride of six or seven hours over a steep but fairly good road for horses takes one to a cave, at an elevation of about 13,700 feet, where camp is usually made for the second night. The work of the third day is severe, and preparations should be made for a good breakfast and an early start. These items must be looked after by the tourist himself, as the guides are in no hurry, and an ordinary Mexican breakfast would not do for an American or Englishman who has a day of hard work before him. Starting early on the third morning, one rides to the foot of the moraine, near the 16,000 feet level, above which the slope is too steep for horses and the real work of the ascent begins. (See *A*, Fig. 1.)

The ascent from this point is made along a ridge which forms the eastern boundary of the glacier. In the dry season the tourist climbs slowly upward over rock and ice without danger, except such as may arise from severe exertion in the rarified air of such great elevations.

In the wet season the rocks and ice are more or less thickly covered with snow, which necessitates precautions not called for during the dry season. The eyes should be protected by colored glasses, and the face by a thick veil from the heat and light reflected from the snow, and the feet should be wrapped in coarse cloth to protect them from cold and to prevent slipping on the crusted snow. The chief guide leads the party, cutting steps in the snow for himself and followers. One might miss his footing and slide to his death on the rocks below, but the danger is not great if the instructions and example of the guide are followed carefully. It requires considerable exertion to climb steep slopes at low elevations, but when the elevation is so great that nearly or quite half the air is below, the least exertion is exhausting.

FIG. 6.—The Peak from the west at the 10,000 ft. level.

The lungs can get oxygen enough to supply the system when at rest, and one may ride from the sea-level to the 16,000 feet level without discomfort from light air. Above 16,000 feet, one not accustomed to the air of such elevations can climb but a few feet before sinking down in utter exhaustion, gasping for breath, with palpitating heart, oppressed brain, and possibly a qualmy stomach. After a brief rest the unpleasant symptoms pass away, then a little climb, then a rest, and so upward, the climbs getting shorter and the rests longer till at length the summit is reached. Some can climb faster than others; a good rule is to climb so far as possible without opening the mouth to breathe, then rest. On the average, one does well to climb 500 feet an hour.

Edward Whymper speaks of a "mountain sickness" which affected him and his assistants while exploring among the high Andes. Some of us had a little nausea, but we did not attribute it to the rarified air, and Mr. Bunsen had a severe headache while on the summit, which passed away soon after the descent began, but none of the party was affected with the mountain sickness of Whymper. No other locality on the globe affords such a full and comprehensive panoramic view as does the eastern slope of Citlaltepetl, whether seen from shipboard some 20 or 30 miles at sea, or from the summit of the mountain. The view from the summit is clearest during the forenoons of the wet season when the air is free from dust and usually clear. During the dry season a dust or haze pervades the air to an elevation of 9,000 or 10,000 feet so that objects below that elevation cannot be distinctly seen.

The descent is made to the cave or to Chalchicomula for the night, and Vera Cruz may be reached on the fourth day; thus practically making a journey from the tropical to the polar region and return in four days. Nowhere else on the earth can this be done as easily, quickly, and safely as on the eastern slope of Citlaltepetl, the Star Mountain of North America.

NOTES AND NEWS.

IN October, 1891, Thomas George Hodgkins, Esq., of Setauket, New York, made a donation to the Smithsonian Institution, the income from a part of which was to be devoted "to the increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man." With the intent of furthering the donor's wishes, the Smithsonian Institution now announces the following prizes to be awarded on or after July 1, 1894, should satisfactory papers be offered in competition: 1. A prize of $10,000 for a treatise embodying some new and important discovery in regard to the nature or properties of atmospheric air. These properties may be considered in their bearing upon any or all of the sciences—e.g., not only in regard to meteorology, but in connection with hygiene, or with any department whatever of biological or physical knowledge. 2. A prize of $2,000 for the most satisfactory essay upon (*a*) The known properties of atmospheric air considered in their relationships to research in every department of natural science, and the importance of a study of the atmosphere considered in view of these relationships. (*b*) The proper direction of future research in connection with the imperfections of our knowledge of atmospheric air, and of the connections of that knowledge with other sciences. The essay, as a whole, should tend to indicate the path best calculated to lead to worthy results in connection with the future administration of the Hodgkins foundation. 3. A prize of $1,000 for the best popular treatise upon atmospheric air, its properties and relationships (including those to hygiene, physical and mental). This essay need not exceed 20,000 words in length; it should be written in simple language, and be suitable for publication for popular instruction. 4. A medal will be established, under the name of the Hodgkins Medal of the Smithsonian Institution, which will be awarded annually or biennially, for important contributions to our knowledge of the nature and properties of atmospheric air, or for practical applications of our existing knowledge of them to the welfare of mankind. This medal will be of gold, and will be accompanied by a duplicate impression in silver or bronze. The treatises may be written in English, French, German, or Italian, and should be sent to the Secretary of the Smithsonian Institution, Washington, before July 1, 1894, except those in competition for the first prize, the sending of which may be delayed until Dec. 31, 1894. A principal motive for offering these prizes is to call attention to the Hodgkins Fund, and the purposes for which it exists. Suggestions and recommendations in regard to the most effective application of this fund are invited. It is probable that special grants of money may be made to specialists engaged in original investigation upon atmospheric air and its properties. Applications for grants of this nature should have the indorsement of some recognized academy of sciences, or other institution of learning, and should be accompanied by evidences of the capacity of the applicant, in the form of at least one memoir already published by him, based upon original investigation. To prevent misapprehension of the founder's wishes, it is repeated that the discoveries or applications proper to be brought to the consideration of the committee of award, may be in the field of any science or any art without restriction; provided only that they have to do with "the nature and properties of atmospheric air in connection with the welfare of man." Information of any kind desired by persons intending to become competitors will be furnished on application. All communications in regard to the Hodgkins Fund, the Hodgkins Prizes, the Hodgkins Medals, and the Hodgkins Fund publications, or applications for grants of money, should be addressed to S. P. Langley, Secretary of the Smithsonian Institution, Washington, U.S.A.

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Attention is called to the "Wants" column. It is invaluable to those who use it in soliciting information or seeking new positions. The name and address of applicants should be given in full, so that answers will go direct to them. The "Exchange" column is likewise open.

THE VALUE OF A WATER ANALYSIS.

BY W. P. MASON, RENSSELAER POLYTECHNIC INSTITUTE, TROY, N. Y.

A GREAT deal of popular misconception exists upon the subject of the analysis of potable water, and it is commonly supposed that such an examination may be looked upon from practically the same point of view as the analysis of an iron ore. That this belief is founded on fallacy may, however, be readily shown. When an iron ore is submitted for analysis, the chemist determines and reports upon the percentages of iron, phosphorus, sulphur, etc., found therein; and at that point his duties usually cease, inasmuch as the ironmaster is ordinarily capable of interpreting the analysis for himself. Even should the analyst be called upon for an opinion as to the quality of the ore, the well-known properties of the several constituents make such a task an easy one, and, assuming the sample to have been fairly selected, the opinion may be written without any inquiry as to the nature of the local surroundings whence the ore was taken.

A water analysis, on the other hand, is really not an analysis at all, properly so-called, but is a series of experiments undertaken with a view to assist the judgment in determining the potability of the supply. The methods of conducting these experiments are largely influenced by the individual preferences of the analyst, and are far from being uniform or always capable of comparison, thus often introducing elements of confusion where two or more chemists are employed to analyze the same water. Some of the substances reported, "albuminoid ammonia," for instance, do not exist ready formed in the water at all, and are but the imperfect experimental measures of the objectionable organic constituents, which our present lack of knowledge prevents our estimating directly.

Thus the numerical results of a water analysis are not only unintelligible to the general public but are not always capable of interpretation by a chemist, unless he be acquainted with the surroundings of the spot whence the sample was drawn, and be posted as to the analytical methods employed.

It is very common for water to be sent for analysis, with the request that an opinion be returned as to its suitability for potable uses, while at the same time all information as to its source is not only unfurnished but is intentionally withheld, with a view of rendering the desired report unprejudiced in character.

Such action is not only a reflection upon the moral quality of the chemist, but it seriously hampers him in his efforts to formulate an opinion from the analytical results.

For instance, a large quantity of common salt is a cause for suspicion when found in drinking water, not because of any poisonous property attaching to the salt itself, but because it is usually difficult to explain its presence in quantity except upon the supposition of the infiltration of sewage; yet an amount of salt sufficient to condemn the water from a shallow well in the Hudson valley, could be passed as unobjectionable if found in a deep-well water from near Syracuse, N. Y.

We thus see how important it is for the chemist to be fully acquainted with the history of the water he is to examine, in order that he may compare his results in "chlorine" with the "normal chlorine" of the section whence the sample is taken. A knowledge of the history of the water is no less important in order to interpret the remaining items of a water analysis. Some time since a water was sent from Florida to this laboratory for examination, and was found to contain 1.18 parts "free ammonia" per million.

Much "free ammonia" commonly points to comtamination from animal sources, and had it not been known that the water in question was derived from the melting of artificial ice made by the ammonia process, the enormous quantity of ammonia found would have condemned it beyond a peradventure. As it was, the water was pronounced pure, the other items of the analysis having been found unobjectionable.

Analytical results which would condemn a surface-water are unobjectionable for water from an artesian well, for the reason that in the latter case high figures in "free ammonia," "chlorine," or "nitrates" are capable of an explanation other than that of sewage infiltration. Even though such water should have, at a previous period, come in contact with objectionable organic waste material, yet the intervening length of time and great distance of underground flow would have furnished abundant opportunity for thorough oxidation and purification.

"Deep" samples taken from the same lake, at the same spot and depth, will greatly vary in analytical results if the temperature of the water at the several dates of sampling should be markedly different, owing to the disturbing influence of vertical currents.

Again, suppose it is desired to determine whether or not the water of a large stream is so contaminated with up-stream sewage as to be unfit for a town supply. An analysis of the water taken from the site of the proposed in-take would very probably be valueless, because the enormous dilution to which the admitted sewage would have been subjected would remove from the analytical results everything of an absolute character. Examinations of any real value in such cases should always be of a comparative nature. Samples should be taken above and below the point of contamination and again at the proposed in-take. If the difference between the first and second samples, which is a measure of the pollution, be maintained, or nearly so, at the point of in-take, then the water should be condemned no matter how completely the analytical results fall within the limits of the so-called standards of organic purity.

Thus it is that a chemist must be in full possession of all the facts concerning the water which he is asked to examine, in order that his opinion as to its purity may be based upon the entire breadth of his passed experience, for in no branch of chemical work is experience and good judgment better exercised than in the interpretation of a water analysis.

As Nichols has well said, "It is a great mistake to suppose that the proper way to consult a chemist is to send a sample of water in a sealed vessel with no hint as to its source. On the contrary, the chemist should know as much as possible as to the history and source of the water and, if possible, should take the samples himself."

In the taking of samples for so important a matter as a town supply, the chemist should unquestionably personally superintend their collection; but, for individual outlying waters, printed instructions have to be frequently depended upon. Those issued from this laboratory are as follows: —

DIRECTIONS FOR TAKING A WATER SAMPLE.

Large glass-stopper bottles are best for sampling, but as they are seldom at hand, a two-gallon, new demijohn should be employed, fitted with a new soft cork. Be careful to notice that no packing straw or other foreign substance yet remains in the demijohn, and thoroughly rinse it with the water to be sampled. Do not attempt to scour the interior of the neck by rubbing with either fingers or cloth. After thorough rinsing, fill the vessel to

overflowing so as to displace the air, and then completely empty it.

If the water is to be taken from a tap, let enough run to waste to empty the local lateral before sampling; if from a pump, pump enough to empty all the pump connections; if from a stream or lake, take the sample some distance from the shore, and plunge the sampling vessel a foot and a half below the surface during filling, so as to avoid surface scum.

In every case fill the demijohn nearly full, leaving but a small space to allow for possible expansion, and cork securely. Under no circumstances place sealing-wax upon the cork, but tie a piece of cloth firmly over the neck to hold the cork in place. The ends of the string may be afterwards sealed if necessary.

Bear in mind, throughout, that water analysis deals with material present in very minute quantity, and that the least carelessness in collecting the sample must vitiate the results. Give the date of taking the sample, as full a description as possible of the soil through which the water flows, together with the immediate sources of possible contamination.

STARFISHES OF THE INDIAN OCEAN.

BY DR. R. W. SHUFELDT, TAKOMA, D. C.

BIOLOGICAL work of a very excellent character has within the last few years been accomplished in the Indian Seas through those employed on board H. M. Indian Marine Survey steamer, "Investigator," Commander C. F. Oldham, R.N., commanding. Much of this success is due to the labors of Mr. A. Alcock, Surgeon-Captain, I.M.S., and late Naturalist to the Survey.

Mr. Alcock has recently sent me from Calcutta a copy of his work, entitled "An Account of the Collection of Deep-Sea Asteroidea," from the region just mentioned — it being an extract from the *Annals and Magazine of Natural History* (Ser. 6, Vol. XI.) for February, 1893. From it, it would appear, that since the year 1885 many parts of the Indian Ocean, in waters varying from 100 fathoms to 1,000 fathoms and over, have been very profitably dredged by the naturalists of the "Investigator."

Mr. Alcock remarks, "A large collection of littoral and shallow-water forms [of starfishes] has also been made, but these are not here considered. If it be thought objectionable to have separated the deep-water from the shallow-water forms, it may be urged in justification that within the limits of Indian seas, so far as our experience at present goes, there is no instance of the two sections overlapping, and on another ground, that almost nothing has been published, and nothing else is promised, about the extremely interesting Asteroidea of the deeper waters of India. Of the basins into which these waters may conveniently be divided, the Bay of Bengal proper—the basin best explored by the dredge so far — gives us the smallest number of unknown species. Beyond the limits of the 30-fathom line it would seem as if the overwhelmingly muddy bottom of the bay presented conditions specially unfavorable to the existence of starfishes; and after passing this limit we usually dredge nothing until we reach true bathybial conditions in the middle of the bay" (pp. 73, 74).

On the Andaman side, however, in 561 fathoms of water, they met with *Brisinga*, and opposite to the Kistna and Godávari Deltas, in 500 to 700 fathoms, where the bottom was of a hardening clay, *Flabellum* (*japonicum* and *laciniatum*), *Bathyactis*, *Phormosoma*, and Spatangoids, *Pentagonaster*, again appeared. In the middle of the bay, with a bottom of accumulating *Globigerina*-ooze, the well-nigh cosmopolitan forms of *Pararchaster*, *Dytaster*, *Porcellanaster*, *Styracaster*, *Hyphalaster*, *Paragonaster*, *Zoroaster*, *Marsipaster*, *Hymenaster*, and *Freyella* rewarded the efforts of the dredger.

Peculiarly favorable to starfish-life is the enclosed basin of the Andaman Sea, which thus far, however, has only been examined up to 600 fathoms. Of twenty-one species here collected, no less than sixteen were new to science, including three very remarkable generic types. Eighteen species were dredged in the Laccadive Sea, and other very interesting localities were examined. Little, however, was added to our knowledge of the life-habits of the deep-sea starfishes, though "like some of the common reef-forms they must sometimes live in swarms, as, for instance, *Zoroaster carinatus*, of which over a score have been taken at one haul, *Pontaster hispidus*, of which about fifty have been dredged at the same time, and *Nymphaster florifer*, of which a 150 have come up on the tangle-bar."

The food of these deep-sea types seems mainly to be mollusks, prawns, and amphipods, and in some cases they gorge themselves with *Globigerina*-ooze. "A curious case of symbiosis, which has been observed too often to be a merely accidental association, occurs between *Dictyaster xenophilus* and an annelid."

Mr. Alcock's work forms a brochure of about fifty pages, with some good figures on plates, and throughout the whole he has followed the classification of Mr. Sladen, now well-known to the students of the Asteroidea, through their reading of it in those classical volumes, the "Challenger Reports," to which it was contributed.

THE USE OF POISONS AS FUNGICIDES AND INSECTICIDES.

BY L. R. TAFT, AGRICULTURAL COLLEGE, MICH.

ALTHOUGH copper sulphate has been used for many years for the destruction of the smut spores of wheat and oats, it is only about ten years since it was first employed upon fruit and similar crops as a fungicide, and for fully one-half of this period it was only used in an experimental way.

Its effects have proven so beneficial, however, that the fruit-growers, of the State of Michigan alone, will this year use several tons in combatting the various diseases that infest their crops.

The amount in time and materials expended in the use of fungicides in the United States must then reach many thousands of dollars, and it is very desirable that as much light as possible be secured upon the time and number of the applications that are necessary to obtain the best results, as well as upon the mixtures that will be most effective and economical. It has been clearly shown by many experiments that, to be most effective, the applications must be made early in the season, before the disease has obtained a foothold; but, as the number of sprayings required to hold the disease in check will depend upon such conditions as character of crop, season, and location, and the prevalence of the disease, it is doubtful if anything more than a general rule can be given, and this must be modified to suit the conditions.

Experiments have demonstrated that very small amounts of the salts of copper will destroy the spores of fungi, and have shown that the original formulæ for most of the fungicides were deficient in water, or, in other words, the mixtures were unnecessarily concentrated. Although, as now used, the strength has been greatly decreased, the limit has by no means been reached. The amount of copper sulphate in Bordeaux-mixture has been reduced from sixteen to six pounds for twenty-two gallons of water, and the experiments of the writer tend to show that for many diseases one or two pounds are fully as beneficial.

Two or three years ago most writers recommended some form of ammoniacal solution of copper carbonate, but, after a thorough trial, most fruit-growers have come to consider Bordeaux-mixture preferable to any of the ammonia-containing mixtures. The ammonia solutions were commended as being cheaper and easier to apply, but, in fact, the Bordeaux-mixture of the same strength is much less expensive; if properly strained it is not likely to clog the pump or nozzles; it is less easily washed from the plants; and it is not only less likely to injure the foliage, but it allows the arsenites to be used at the same time, thus forming a combined fungicide and insecticide, and the lime also prevents all injury from the arsenic.

For these reasons the Bordeaux-mixture is preferable, and its use should be commended.

This lime-mixture covers the plants with a sort of whitewash, and, although this is in one way objectionable, in another, from the consumers' standpoint at least, it is preferable to some of the clear solutions, which, although they contain fully as much poison, are not very noticeable upon the plants.

Fruits sprayed within a few days of the time of gathering would in one case not be saleable, and in the other, although

they might have upon their surface a sufficient amount of poison to produce injurious effects, would seem above suspicion.

The results obtained from spraying various fruits with a combined fungicide and insecticide in 1892 convinced the writer that too great care cannot be taken in the use of these poisons upon all crops, any exposed portions of which are edible, and that in no case should they be used within one month of the time of ripening, while an interval of six weeks to two months will be preferable. The fruits experimented upon were strawberries, raspberries, currants, gooseberries, cherries, and pears. The experiment was conducted in the same manner with all of the fruits, and when ripe they were analyzed and tested for arsenic and sulphate of copper. The spraying was done about as in ordinary practical work, except that it was rather more thorough, the amount used being perhaps double that generally employed. Except that the raspberry and strawberry retained rather more of the poison, the results were quite similar, and those obtained with two of the fruits will answer for all.

Gooseberries sprayed June 18, 29, July 8, and 22 with Bordeaux-mixture (copper sulphate, 2 pounds; lime, 1½ pounds; water, 32 gallons) and London purple (1 pound to 200 gallons), using one-half gallon of the mixture to a very thick, full row two rods long. One pound of fruit gathered Aug. 2 gave, on analysis, .0365 grains of arsenic and .355 grains of copper sulphate. In making the analysis, the fruit was first washed in ten per cent hydrochloric acid, and the amounts of arsenic and copper sulphate thus abstracted were, respectively, .0203 grains and .208 grains, after which there remained of each .0162 grains and .147 grains.

Fruit from another row that had been sprayed in a similar manner, except that the Bordeaux-mixture was made from the usual formula (copper sulphate, 6 pounds; lime, 4 pounds; water, 32 gallons), gave of arsenic .0723 grains, and of copper sulphate .62 grains, from one pound. In each case the last spraying was eleven days previous to the date of picking.

The pears were sprayed with the same mixture as the first lot of gooseberries, on June 15, July 7, 21, and Aug. 7, and were gathered and analyzed Sept. 6, or thirty days after the last application. The result from one pound of fruit gave, of arsenic .0089 grains, and of copper sulphate .0745 grains.

The above analyses were made under the direction of Dr. R. C. Kedzie, chemist of the Michigan State Experiment Station.

Attention is called to the fact that only about one-fifth as much copper sulphate was found upon the pears thirty days after spraying as upon the gooseberries gathered eleven days after receiving the last application, also that with a weak solution as compared with a strong one, the amount both of copper and arsenic remaining upon the fruit was reduced in about the same ratio as the strength of the mixture used.

This certainly emphasizes the advice previously given, (1) to use a solution as weak as will secure freedom from disease, and (2) cease spraying with all poisons at least one month before the fruit ripens.

LIGHTHOUSE ILLUMINANTS.

BY WM. P. ANDERSON, CHIEF ENGINEER OF MARINE DEPARTMENT, OTTAWA, CANADA.

IN *Science* for Feb. 6, 1885, a sketch was given of the progress of lighthouse illumination in Great Britain and Ireland, together with a short description of the strongest lights and apparatus utilized up to that time. Since that article appeared the conflict between the advocates of electricity, mineral oil, and gas, respectively, has not decreased, nor has any settlement satisfactory to all parties yet been reached. The matter has on several occasions been brought before the Imperial Parliament, and in February last some further correspondence on the subject was laid before the House of Commons.

A consideration of some of the points lately elicited will be an interesting addition to Mr. Kenward's notes on lighthouse apparatus in *Science* for April 21 last.

The lighthouses of the United Kingdom are under divided control: the English lights are managed by the Trinity House, the Scotch lights by a board of commissioners, and the Irish lights by a separate commission; all under the general direction of the Government Board of Trade, and each anxious to maintain lights of the highest efficiency, almost regardless of cost.

The English authorities, from the observations made in 1885, are satisfied of the superiority of electric arc-lights where the highest possible power is required, and consider oil-lights the cheapest and most easily managed for ordinary purposes. The Scotch commissioners endorse this view of the case; but the Irish board seems to favor the use of illuminating gas.

The chief opposition to the decision of the English Trinity House appears to be instigated by Mr. John R. Wigham of Dublin, the inventor of the gas system. He claims that he did not get fair play in the trials of 1885, because a rule was adopted restricting the size of the lenses and lanterns within limits that prevented him from obtaining the best results from his gas-lights. Since that time he further claims that by enriching common gas with hydrocarbon a greater amount of light can be obtained from it than from the richest cannel-coal gas. Actual experiments have shown that cannel-coal gas has an illuminating power of 28 candles, nearly double that of ordinary Newcastle-coal gas, 16 candles. By passing the ordinary gas through the vapor of solid napthaline, or albo-carbon, a perfectly safe and inexpensive material, it is enriched with hydrocarbon to such an extent as to give double the illuminating power of cannel gas. He also suggests, as an improvement in lighthouse illumination, placing lenses so as to form a quadrilateral or trilateral figure, which would permit the use of lenses of much larger illuminating surface and of much longer focal distances than is possible with the 6, 8 or even 16-sided lenticular apparatus heretofore used, thereby immensely increasing the illuminating power of the lighthouses.

Mr. Wigham has had a lens of long focus made, with a bulls-eye or central portion 19 inches in diameter, and two concentric rings, one 4 and the other 4½ inches wide, giving a total diameter of 36 inches, all in one piece. This is surrounded by a belt of prisms 2 feet 10 inches wide, consisting of ten rings, outside of which is a third portion consisting of eight rings of totally reflecting prisms, partially surrounding the second portion, so as to complete a lens about 10 feet 10 inches wide by about 8 feet high. In the focus of this lens is placed an "intensity" burner composed of 148 fish-tail jets, grouped to burn the enriched gas, which, when lighted, forms a solid flame of 14 inches diameter by 6 inches high. The illuminating power of the burner is calculated to be about 8,500 candles, which should give an actual intensity of light through the lenses of about 2,300,000 candles. Experiments made with this apparatus showed splendid results at a distance of 6¼ miles. In full moonlight the beam cast a strong shadow, and was very large and dazzlingly bright, reducing a neighboring first-order fixed light to what seemed by comparison a remote and feeble glimmer.

The case for and against gas as a lighthouse illuminant seems to be as follows: Its advantages are facility in increasing or decreasing the power of the light to suit the various states of the atmosphere, and also speed and sharpness in eclipsing lights by cutting off the supply of gas, and thus occulting them while at the same time saving the illuminant; as well as the fact that where gas is used for illumination it can be utilized at a minute's notice to operate a gas-engine in connection with a mechanical fog-alarm, while with any other source of power delay must occur in putting the fog-alarm into operation. It is further claimed that the large size of the gas-flame, giving an unusual number of extra-focal rays, has a better effect in illuminating a large area of fog, and consequently makes the light more readily visible.

The weak points of gas are the difficulty of manufacturing it at some isolated stations, and also the necessarily large size of the flame, which involves the use of very large lenses, and a long focus, to prevent a wasteful distribution of extra-focal light.

The arrangement of illuminating apparatus proposed by Mr. Wigham for a most powerful light is a battery of four giant lenses, surrounding a central burner, intensified by having similar lenses with additional burners arranged one over the other in three tiers, or "in triform." To accommodate such an apparatus would require a lantern with glazing at least 20 feet in diameter

by 24 feet high. The lenses alone would cost £8,400, an expenditure which would only be justified by the necessity for an exceptionally powerful light.

Mr. D. A. Stevenson, Engineer to the Northern Lighthouse Board, in a report on electric light as an illuminant, claims that the complaints against the penetration of this light in fogs are not well founded, and that many criticisms of its power are due to prejudice, partly owing to the persistent way in which it is decried as a lighthouse illuminant by certain writers to the press, partly from a misunderstanding of the fact that, being very rich in the most refrangible rays of the spectrum, that is, very white, it suffers a greater percentage of diminution in passing through fog than oil or gas light, which is redder, but nevertheless, owing to its enormously greater initial power, the electric light is always a better penetrator of fog than the others. He claims that sailors, on their ordinary courses, are never in a position to form an opinion of the subject that is worth anything, because they cannot see different lights in the same conditions of atmosphere. He adduces observations made by keepers in his service on each other's lights, which go to prove that the electric light is in all cases the more powerful. These are observations from one station burning an oil light to another electrically lighted, and the reverse. Three pairs of such stations are instanced; in every case the electric light being visible in fog that totally obscured the oil lamp.

THE COLLECTION OF FOSSIL MAMMALS IN THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK.

BY HENRY F. OSBORN, COLUMBIA COLLEGE, NEW YORK CITY.

THE third expedition from the Museum is now in the field, and the collections of fossil mammals made under the direction of Dr. J. L. Wortman during the summers of 1891 and 1892, are being rapidly prepared for exhibition upon the geological floor of the museum. The first year's work was in the Wahsatch beds of the Big Horn Mountains, a country which had been very thoroughly explored for Professor Cope. This yielded rather disappointing results, although exceptionally fine material of *Coryphodon* was procured, including very considerable portions of the skeleton, which will soon be mounted for exhibition in the museum. The most unique discovery in this horizon was the skull of *Palæonictis*, an ancient carnivore which has hitherto been represented only by two lower jaws found in the Suessonian of France, the horizon contemporary with the Wahsatch.

Early in 1892 Dr. Wortman, accompanied by Mr. Peterson, who had been for several years on the U. S. Geological Survey, started into the Puerco or basal Eocene beds of northern New Mexico, and by the most energetic and careful search in fields which had also been explored for Professor Cope, succeeded in procuring a very valuable collection of these Lower Eocene types. Among the most unique specimens of this series are the upper and lower jaws of *Polymastodon*, a large-sized successor of the ancient *Plagiaulax* of the Middle Jurassic beds. Another discovery was the skull of *Pantolambda*, an ancestor of Coryphodon. Altogether nearly five hundred specimens were shipped East from this tour. The party then went into the Laramie, in search of the Triceratops, but were unsuccessful. They secured later in this horizon a large collection of the minute teeth of the Cretaceous mammals, which is paralleled only by that in the U. S. Geological Survey collection.

The richest results obtained thus far, however, are from the White River Miocene of South Dakota. Here the beds are 800 feet thick, and a thorough exploration was made from the bottom series in which the huge *Titanotherium* is found, to the top in which the new forms *Protoceras*, *Artionyx* and *Aceratherium tridactylum* were found. These top beds were practically a discovery, for nothing has been recorded from this stratum before, excepting the skull of a female *Protoceras*, which is in the U. S. Geological Survey collection. The male *Protoceras* presents four pairs of protuberances upon the skull, the most exceptional being the large vertical plates upon the maxillaries. This White River Miocene is the classic ground of Leidy's memoirs, but in these and by far the greater part of the literature of this horizon, the animals only of the so-called "Oreodon" stratum have been described, together with the forms from the lower "Titanotherium" stratum. This has been due to the fact that these strata at once attract the ordinary collector by the profusion of bones which are washed out from them. An intervening stratum between the "Oreodon" and "Titanotherium" layer, appears, also, to have been generally overlooked, because of its unpromising exterior. Mr. S. Garman, collecting for the Museum of Comparative Zoölogy, some years ago secured one specimen of the very unique Rhinoceros-like form, *Metamynodon*, the type specimen and the only one which has hitherto been known. Dr. Wortman directed his attention, therefore, especially to the location of this stratum, and succeeded in finding a seam about thirty feet in thickness, which proves to be especially characterized by abundant remains of Metamynodon. The party secured four or five skulls, and one nearly complete skeleton. This animal is distinguished by huge canine tusks in the anterior portion of the head, which give it an appearance quite different from that of the rhinoceros; in fact, the skull and skeleton are entirely peculiar, and unlike any perissodactyl which has been found hitherto. Yet this animal flourished in the midst of large herds of true rhinoceroses, for the diligent search made by the museum party has resulted in the discovery of a whole series of hornless rhinoceroses, from the bottom of these beds to the top. They increase gradually in size, and in the evolution of the teeth, in the loss of the lateral fifth toe in the fore foot, and reach a culminating point in the new species, *Aceratherium tridactylum*. As the name indicates, this species is mainly characterized by the presence of but three toes in the fore foot. It is represented in the museum collection by one of the most remarkable specimens which has ever been found. This is a complete skeleton from the tip of the nose to the tip of the tail, lacking only the fore limb of the left side, and a few of the ribs and sternal bones. It is over seven feet long and four feet high, and has been mounted upon a large panel of sandstone and plaster, giving the impression that it has been simply hewn out of the matrix. The animal appears to be of about the same size and proportions as *Ceratorhinus* or the rhinoceros of Sumatra; in fact it has very nearly the same proportions and form, except that it lacks the small horns upon the nasals and frontals. Among American species its affinities are with the *Aphelops megalodus* Cope of the top of the Miocene.

A third specimen of note is the hind foot of *Artionyx*. As Leidy called Oreodon a ruminating hog, so this animal might be called a clawed hog, for the foot closely resembles that of the pig or peccary, until we reach the phalanges, which have articulations and large terminal claws somewhat similar to those seen in the bears, while the ankle-joint is of the artiodactyl type, and the four toes are set in pairs on either side of the median line, there being also the rudiment of a fifth. The name given this fossil refers to its combination of the artiodactyl and unguiculate character. This is possibly a relative of the clawed Ungulate—*Chalicotherium*—which presents such a remarkable combination of characters, and is now known to have been distributed over North America, Europe, and Asia, during Miocene times. The contrast between these two types is very striking; for while Artionyx combines an artiodactyl foot with uncleft claws, Chalicotherium combines a perissodactyl foot with cleft claws. One of the most interesting problems of the future will be clearing up the relations between these two forms and their relations to other groups.

CURRENT NOTES ON ANTHROPOLOGY.—XXVII.

[*Edited by D. G. Brinton, M.D., LL.D.*]

Theories in Criminal Anthropology.

Two articles which appeared almost simultaneously in February last present with sharpness and brevity the conflicting views of the two leading schools of criminal anthropology.

One is by Dr. Sorel, in the *Revue Scientifique*. It is a warm defence of the doctrines so strenuously urged by Professor Lombroso, and which were substantially repudiated at the Congress of Brussels last year (see *Science*, Nov. 18). Sorel maintains

that the opponents of Lombroso did not understand his assertions, and that they confused the discussion by introducing speculative questions as to the abstract nature of crime, quite out of place in a study in natural history; and much more to the same effect.

The other paper is by the late Professor Meynert, and is printed in the Mittheilungen of the Vienna Anthropological Society. It is principally occupied with a refutation of Lombroso's assertion that genius is a pathological development, or the result of such; but also attacks his theory of crime as attributable to a degeneration of the brain and a reversion to an atavistic condition of the race. Several serious errors in Lombroso's method of handling statistics are pointed out; as, for instance, his neglect of the fact that the depraved physique of the criminal is owing to his unhygienic surroundings, and to attribute his criminality to such physique is to confuse concomitant with cause. Again, in comparing criminals with wild beasts, he confounds the methods of natural history with that of judicial procedure.

A careful reading of the two articles will prove entertaining.

A Chemical Test of the Antiquity of Bones.

The effort was made by M. Adolphe Carnot last summer, in a paper read before the Academie des Sciences, Paris, to establish a chemical measure of the antiquity of bones. He claimed that this is shown by the amount of fluorine they contain. Its relative proportion increases as the bones are older. Representing the maximum by 1, modern bones show but .06, those from the old quaternary strata .35, those from the tertiary .64. Hence, when human and other bones are found in the same strata, and the question whether they should be assigned to the same age arises, analysis is claimed to offer a solution; and M. Emile Rivière had recourse to it as the crucial test in the disputed age of some human bones found along with those of extinct species in the gravels near Billancourt, on the Seine; proving, he believed, that the human bones were intrusive and late.

It seems to me, however, that this test, which I learn about from an abstract in the Journal de l'Alliance Scientifique, March 15, is open to some serious risks.

Not only do the inorganic constituents of bone differ largely in the different osseous tissues of the same skeleton, but they notoriously vary greatly at the different epochs of life. According to the analyses of Heintz, the fluoride of calcium in the average femur of an adult is about 3.5 of its inorganic constituents. Where the proportion in ancient bones differs notably from that in modern, how can we decide what part of it is owing to post mortem changes conditioned on the quality of the soil, the amount of percolation, the length of exposure before inhumation, and the like incidents? While it would be most desirable to have at hand a positive chemical test of antiquity, we must hesitate to accept as conclusive one which seems exposed to be influenced by these precarious conditions.

Cave-Hunting on the Mediterranean.

Shortly after leaving the French frontier on the road which leads from Marseilles to Genoa, the track penetrates by a tunnel the Baoussé Roussé, or Red Rocks, the sea front of which is perforated with natural caverns looking out on the blue Mediterranean. They have furnished rich mines for the archæologist, as they were selected by the earliest of the human race who dwelt there as favorite resting-places for both the living and the dead. Fresh discoveries were made in one of the grottoes in February, 1892, of which a note will be found in *Science*, July 26, 1892, giving the opinion of J. Vaughan Jennings. A still more elaborate study was made by Dr. Verneau, which appears in *L'Anthropologie*, 1892, No. 5. His conclusions, briefly, are that the three skeletons found side by side were an interment dating from a period intermediate between the quaternary and the neolithic epochs; but it had been made in strata containing traces of an older and different industry, which could properly be called quaternary.

Some excavations of MM. Fournier and Rivière, published in *Le Naturaliste*, Feb. 15, 1893, revealed a station of the Magdalenian epoch in a rock-shelter at La Corbière, near Marseilles, and probably as ancient a relic-bearing stratum as has been found in that district.

A curious fact about it was that at the remotest corner of the small grotto was a skeleton, the bones in place, but with no signs of interment, and no funerary objects. Evidently the corpse had been left to decay where the man breathed his last. Either he lived alone, or the others had deserted the grotto on his death. The authors refer to another such instance in another shelter. Probably in these, we see the signs of that horror of death which is one of the earliest prompters of the religious instinct. Tribes are known to history who deserted the dwelling and the corpse within it, when the owner died.

Researches in Early Aryan Ethnology.

One of the most earnest students of the early Aryan tribes is Professor Wilhelm Tomaschek, of the University of Vienna. In a late number of the Mittheilungen of the Anthropological Society of that city he discusses with profound erudition the relationship of the ancient Illyrians and Thracians.

In its first paragraphs he declares himself a believer that the primitive Aryan speech developed itself in Europe, wholly uninfluenced by either Semitic, Coptic, or other affiliations. From an extended comparison of the relics of ancient Illyrian and Thracian — principally proper names — he reaches the conclusion that the east European group of Aryan tongues should be divided into two sub-groups, the one including the Thracian, Phrygian, and Armenian, the analogies of which are with the Celtic and Italic dialects of western Europe; the other comprising the Slavic and Illyrian idioms, whose analogies are with the Lithuanian of the Baltic. The modern Albanian is a true descendant of the Illyrian, though it has suffered much decay, and also presents a number of non-Aryan radicals, which, the author ventures to suggest, survived from the pre-Aryan Ligurian speech of the locality. The Veneti of northern, and the Iapyges of southern Italy belonged without doubt to the Illyrian stock. The Thracian language itself, a pure Indo-Germanic tongue, became entirely extinct; but the author announces the near publication of a work in which he has collected all known relics of it as preserved in epitaphs, inscriptions, and proper names.

The Study of Folk-Tales.

A valuable addition to the science of folk-lore is a work just published by the English Folk-lore Society, from the pen of Miss Marian R. Cox. It is a volume of 535 pages, a monograph on the tale of Cinderella, giving 345 variants, with abundant notes and discussions of analogous narratives from all parts of the world and all periods of history.

An introduction is contributed to the work by Mr. Andrew Lang, in which he endeavors to present what he now believes to be the true explanation of such analogies, carefully refuting various opinions on the subject which he is generally believed to have endorsed. Mr. Lang was once president of the Folk-lore Society, and though he has announced that he has given up that for more lucrative pursuits, his opinions are much respected. He is generally understood to have explained such analogies by the convenient word "chance," and to have been the adherent, if not the parent, of the "casual" theory in folk-lore. Certainly he has denied all definite meaning and all real content in primitive myths. He now modifies these positions by explaining the analogies as based on "the universally human," or else on "common customs." He believes in transmission, "where the incidents are numerous and the sequence exact"; which, indeed, is the only resource for one who, like Mr. Lang, can see nothing in native myths but "the obscene or puerile stories of savages."

Fortunately, we are not driven to take refuge in such vague phrases to explain the striking parallelisms of human thought and expression in tribes far apart in space and time. The scientific explanation of them is based on two factors; first, the fixed laws of the human imagination; and second, the objective reality of the sequences which are symbolically set forth in the narratives. The late story is often the ancient nature myth, decked out by personification and poetry, but still true to those sequences which objectively are ever and everywhere realities.

As for the imagination, what is it but a faculty operating under laws as rigid as those of physics? As the distinguished ethnographer, Von Hellwald, remarks: "In spite of the endless multiplicity of forms, yet often one and the same or very nearly allied forms recur in localities widely asunder, and this seems to occur most frequently in forms which are peculiarly strange and artificial. We are almost forced to accept the discouraging suggestion of Peschel, that the human faculty of thought is a mere mechanism, which under a given stimulus is always forced to perform the same motion."

LETTERS TO THE EDITOR.

**** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

A Physiological Effect of Cave Visiting.

DR. HOVEY'S interesting account of a visit to the Mammoth Cave in March, published in *Science* for April 7, 1893, recalled a recent conversation with my father, Dr. C. Fayette Taylor, on the subject of the cave, which he visited in July, 1860. He was particularly struck with, and vividly describes, the physiological effects experienced on emerging from the cave. He made the usual long trip with some fifteen companions, reaching upper air after a stay of about twelve hours under ground. On emerging the sense of smell was intensified to such an extraordinary degree, that most common objects, such as trees, plants, animals, and even people had strong individual odors, mostly unpleasant; about half the party were strongly nauseated and vomited. One tree could easily be distinguished from another by its characteristic odor. This effect lasted about half an hour and then passed off. The guides told him that this was a usual experience. Dr. Hovey alludes to this effect of a sojourn in the cave in a lecture published in the Bulletin of the American Geographical Society, March 31, 1891, in the following words: "By contrast with the pure oxygenated air of the cave, the odors of the outside world, of the trees, grass, weeds, and flowers, are strangely intensified and for many delicate natures overpowering." In a letter dated April 11, 1893, Dr. Hovey says: "I have always, or generally, been accustomed to rest at the entrance on emerging, for the reason that neglecting this precaution is apt to be followed by disagreeable consequences. I have know visitors to suffer from nausea and headaches by reason of a too sudden change from the peculiarly pure air of the cave to that of the outside world. The sense of smell is greatly intensified in almost every case."

I judge that this intensification of olfactory perceptions is due to the rarity of olfactory stimuli in the cave; on emergence, in accordance with a physiological law, the perceptive powers for these particular stimuli, having rested, are intensified, so that odors too delicate to make an impression under ordinary circumstances are powerfully felt. By the constant repetition of the ordinary olfactory stimuli this effect passes off, and soon only the stronger odors are registered in consciousness. In other words, consciousness is mainly concerned with the registration of the contrast between the stimulus of the moment and a background of fused and undifferentiated impressions. Ordinarily, sensations are increased by more intense stimulation, but they may also be increased, as in the illustration just given, by varying the background so as to bring ordinary stimuli into stronger relief. That a similar effect has been intensified by heredity is illustrated by Dr. Hovey's remarks on the auditory sensitiveness of the cave fauna. He says in the lecture already referred to: "The tiny [blind] fish are colorless, having cartilage instead of bones, are viviparous, and are so sensitive that if a grain of sand should fall on the water they would dart away with rapidity. Blind crawfish are also found here, whitish, semi-transparent, with remarkably long antennæ and more delicate in every way than those found in outside streams. These also are highly sensitive and not easily captured."

This agrees with an observation of Professor Cope, quoted in the "Standard Natural History," Vol. III., p. 173. He says the Amblyopses, when swimming near the surface, as is their habit, are "easily taken by the hand or net, if perfect silence be preserved, for they are unconscious of the presence of an enemy, except through the sense of hearing. This sense is, however, evidently very acute, for, at any noise, they turn suddenly downward and hide beneath stones, etc., at the bottom."

HENRY LING TAYLOR, M.D.

New York.

Pre-Historic Remains in America.

IF Professor Thomas, in *Science*, May 5, had really desired to inform readers what my conclusion was in reference to the original home of the Mexican or Uto-Aztecan stock, he would have quoted, not various fragments from earlier studies, but the following from "The American Race," p. 121: "That very careful student, Mr. George Gibbs, from a review of all the indications, reached the conclusion that the whole group came originally from the east of the Rocky Mountain chain, and that the home of its ancestral horde was somewhere between these mountains and the Great Lakes. This is an opinion I have also reached from an independent study of the subject, and I believe it is as near as we can get to the birthplace of this important stock."

What I said of the Mayas was: "The uniform assertion of their legends is that the ancestors of the stock came from a more northern latitude, *following down the shore of the Gulf of Mexico.*"

If Professor Thomas can controvert either of these propositions, I shall be glad to change my views to his.

As for his assertion that I "ought to know" that the shells and copper ornaments found in Tennessee and Georgia "are looked upon by all archæologists as puzzling objects because of their remarkable departure from the types of the Atlantic slope," I certainly know nothing of the kind, nor does Professor Thomas. Only last summer that most competent archæologist, Dr. E. Seler, published an article to show that these very objects are so little of a departure from historic Atlantic types that the theory of a relationship to Maya art is in his opinion unnecessary (see *Science*, Nov. 4, 1892).

If Professor Thomas had made himself acquainted with the current literature of American archæology, he would not have risked such a statement. D. G. BRINTON.

Philadelphia, May 8.

Tornadoes.

ABOUT five o'clock of the evening of April 24, a peculiar wavy appearance was noticed in the clouds, which were moving north. Every few minutes one or more miniature tornadoes would appear. The little funnels would last twenty or thirty seconds, others formed only to be destroyed shortly afterwards.

The whole time was about fifteen minutes, when the upper layers of clouds became more or less mingled with the lower layers. The barometer had been falling all day. The same evening there were two destructive tornadoes in Missouri and a heavy wind-storm at Paxton, Ind. E. M. DANGLADE.

Vevay, Ind., April 29.

Pivotal Sounds in Recollection.

IN 1884 I published the statement that in the endeavor to recall some forgotten word or name that a remarkable tendency existed to substitute another word or name having, somewhere in its construction, a letter corresponding to one in the desired word or name. For example, Cavendish suggests itself, or rather may do so, when one is trying to recollect Van Antwerp, and so on; the V being the pivot upon which both names revolve, apparently, in the memory. In addition to this I find, at least in my own experience, an inclination to swing these memory efforts around the R sound more frequently than with other instances; for example,

for many years, and slightly to this day, I hesitate in naming Dearborn and Randolph Streets. Of course, any one living upon either of these streets would soon overcome such confusion through one name appearing oftener than the other in use.

The knowledge of this disposition has enabled me sometimes to recover the proper word by taking other words with the same "pivotal" letter, or sound, regardless of their sequence in spelling the word sought.

S. V. CLEVENGER.

Supt. Ill. East. Hospital for Insane.

Singing of Birds.

IN reply to a query by E. B. Titchener (*Science*, April 7) with regard to the expression of emotions in the singing of birds, I have a few notes. A song-sparrow, *Melospiza melodia*, with a broken leg past mending, was kept in our house in a cage about a year and a half, fed, bathed, otherwise cared for and occasionally allowed the freedom of a room. A happier, merrier fellow, I never saw. He sang early and late, nearly the year round, moped a few days and died. The taxidermist said he was much wasted in flesh, and had lived as long as he could. He was kept as comfortable as possible, and his song seemed purely an expression of happiness.

MARY B. MOODY.

Fair Haven Heights, New Haven, Conn., May 2.

Photographs of Botanists.

YOUR botanical subscribers and readers most likely will be interested in the collection of photographs of about 150 American botanists and a small number of foreign botanists, that Michigan State Agricultural College is displaying in the Departments of Liberal Arts at the Columbian Exposition.

I hope still others of the "fraternity" will be willing to add a cabinet-sized picture of themselves to a supplementary list, to gratify their friends.

W. J. BEAL.

Agricultural College P. O., Mich., May 3.

BOOK-REVIEWS.

Coal-Pits and Pitmen: A Short History of the Coal Trade and the Legislation Affecting It. By R. NELSON BOYD. London, Whittaker & Co., 1892. 256 p. 12°.

IN this volume, which is an enlarged edition of a paper published under the title of "Coal-Mine Inspection: Its History and Results," the author has gathered a great number of facts relative to the subject. In one chapter he gives an account of the condition of the colliery population during the last century, which is not a pleasing one. The harsh methods of treatment led to many strikes and great destruction of property. The men were at first practically slaves, but an act of Parliament passed in 1775 and another in 1799 did away with the system of bondage, although with little benefit to the men at first. Subsequent acts have mitigated the rigors of their condition and protected them from the rapacity of mine owners and overseers.

The history of the coal trade is treated of in considerable detail, and mention is made of early explosions and means of ascertaining the presence of fire-damp. The early machinery, of a very primitive character compared with modern appliances, is also described. The investigations of one of the various Parliamentary committees show the condition of the colliery operatives in 1833. In referring to this subject, Mr. Boyd states that, "The children were frequently beaten by the men for whom they worked; so much so, that 'they seldom slept with a whole skin.' Besides this, their backs were cut with knocking against the roof and sides of the roadway, and their feet and legs covered with sores and gatherings, owing to the water. The children, boys and girls, earned their wages by drawing the coals in tubs along the galleries by means of a belt and a chain passing between the legs. Many girls were thus employed, and after a time became crooked and deformed. From the nature of the work they soon became as rough and uncouth as the men and boys, fighting and swearing like them."

Considerable attention is given to colliery explosions, and the

CALENDAR OF SOCIETIES.

New Mexico Society for the Advancement of Science, Las Cruces, N.M.

April 6.—F. C. Barker, The English Form of Government; C. H. Tyler Townsend, Life Zones of the Organ Mountains in Southern New Mexico.

Anthropological Society, Washington.

May 2.—Henry Gannett, Estimates of Wealth; Wm. T. Harris, The Great Benefit to the Public of the Estimates of Wealth; Anita Newcomb McGee, Transmission of Congenital Deformity; J. D. McGuire, The Evolution of Stone Working.

May 9.—J. N. B. Hewitt, Common Errors in Regard to Indian Language; H. E. Warner, Primitive Belief in a Future State: a Comparative Study; F. A. Seely, The Pivot Point in Modern History: Andrew Palaeologus at Barcelona; Thomas Wilson, Fourth Centenary of the Discovery of America, at Madrid, 1892.

Geological Society, Washington.

May 10.—Walter H. Weed, The Post-Laramie Beds of Montana; J. S. Diller, The Tertiary Revolution in the Topography of the Pacific Slope.

Philosophical Society, Washington.

May 13.—E. D. Preston, Remarks on the Method of Reducing the Waikiki Observations for Changes of Latitude—Results; F. H. Cushing, Ancient Pueblo Arches; Cleveland Abbe, The Formation of Rain; G. K. Gilbert, The Average Temperature of the Earth.

long list of these is simply appalling. In spite of many improvements, their number even in recent years is not small, although, as a rule, they are not quite as disastrous as they formerly were. Over 5,500 lives have been lost from this cause in England alone between 1850 and 1889. We can commend the volume to all persons interested in the subject of coal and coal mining.

J. F. J.

The Student's Handbook of Physical Geology. By A. J. JUKES-BROWNE. Second edition, revised. London and New York, G. Bell. 1892. 666 p. 8°.

THE breadth of view expressed in the preparation of this excellent text-book makes it more worthy of notice in an American journal than most English books are. Its illustrations, both verbal and graphic, are of course largely British; but so many examples are taken from other parts of the world that its insular origin is not prominent. Its various chapters suggest many of the newer points of geological view; its style is simple and easy, inciting the student to further reading than the end of his lesson. As is the case with most text-books on geology, the treatment of the chapters on sedimentary deposits and on the origin of valleys shows clearly how much later an understanding was reached in the latter than in the former subject. Stratified rocks are described as if they were manifestly the product of aqueous deposition; but the origin of valleys by aqueous denudation is carefully argued out, with a series of proofs. Buried valleys are mentioned before drowned valleys, although the natural order of occurrence is the other way. From my own greater interest in physiographic geology than in the other chapters of the book, my attention is naturally directed towards that part of the subject, especially as the author recognizes it as a primary division of the science. While its treatment is greatly in advance of that which it commonly receives, it still leaves something to be desired before it shall be commensurate with its importance and with the treatment of other equally important but more attentively considered chapters. For example, it is implied that anticlines are normally transformed into valleys, and synclines into mountains; while it is easily shown that this transformation is not dependent on the attitude but on the hardness of the beds involved in the folding and on their relation to base-level. Again, in the discussion of sub-aerial denudation and the origin of valleys, no reference is made to the completion of the task of valley-making in the base-levelling of the region; and plains of denudation are referred to only as a product of marine erosion.

The book may be warmly recommended for the reference shelves of school libraries, and until the variety of American text-books of geology is increased, it will doubtless share with Geikie's smaller "Geology" a place in our schools and colleges.

W. M. D.

ONE of the largest cases in the Century Company's room at the World's Fair is devoted to an exhibit of "how a dictionary is made." Beginning with a copy of the very earliest English dictionary, Bullokar's "English Expositor," printed in London in 1616, a half-dozen of the important dictionaries of the past are shown, up to Bailey's, Johnson's, and the Imperial, the latter of which was the basis of the Century Dictionary. The exhibit includes a copy of the edition of Bailey's which was the first to include cuts, or "engraven schemes," as they are called on the title-page. In order to picture the growth of the language, especially in scientific lines, each book is open at the words beginning with "micro," of which in the first dictionary there is but one word, "microcosmus," while in the Century there are eight pages of the compounds of "micro." These eight pages, from the first manuscript, through the various proofs (showing additions and corrections) up to the finished dictionary, form the exhibit, with the addition of plates, original pictures, engravings on wood, and the manuscript and proofs of the word "take." With the latter are the quotations and definitions, used and unused, handed in by readers. The entry under "take" occupies about twelve columns in the dictionary, but it will be seen that not more than half of the material gathered was finally used.

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For sale—A complete set of the Reports of the Second Geological Survey of Pa., 1874-1893, including the Grand Atlas. Publisher's price over $115. Will sell for $50. Address F. D. Chester, Newark, Del.

The undersigned has skins of Pennsylvania and New Jersey birds, as well as other natural history specimens: which he wishes to exchange for marine, fresh water, and earthworms of the South and West. Correspondence with collectors desired. J. Percy Moore, School of Biology, University of Pennsylvania, Philadelphia.

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First inserted June 19, 1891. No response to date.

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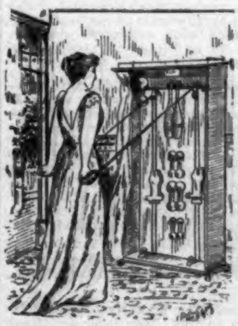

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